Publication number:	DE2729353 (A1)
Publication date:	1979-01-11
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Classification:	
- international:	*A61B6/02; A61B6/03; H01J35/14; H01J35/24; H05G1/10;* A61B6/02; A61B6/03; H01J35/00; H05G1/00; (IPC1-7): H01J35/24
- European:	A61B6/02; A61B6/03B10; H01J35/14; H01J35/24; H05G1/10
Application number:	DE19772729353 19770629
Priority number(s):	DE19772729353 19770629

X ray tube with moving focal spot

The invention relates to X ray tube with moving focal spot, in particular to the application with Roentgen tomography procedures.

Such methods e.g. are. known from “handbook of the medical radiology Bd. 1, part 2 (1965) sides 203 to 212.

With the known apparatuses, how they are for instance in aforementioned literature place described, always at least one becomes the emergency agile elements, i.e. one from the group beam source, investigation object and recording device, moved. However usually the patient becomes quiet maintained and at least the beam source displaced. This requires however large effort at energy and time. This is based on the fact that the beam source is heavier because of the required shield and in motion set as well as again decelerated must become.

This means however large time for a einelne receptacle. Shortest recording times of 200 MSEC (milliseconds) resulted. For the receptacle of moved organs, for instance the heart, however tomography times of 80 MSEC would have to become achieved. Appears in addition to bottom consideration of the courses of motion single heart portions within the heart impact phase one tomography duration of < 20msec worthwhile.

Such rapid movements are not more achievable with the apparatuses known from the state of the art.

In the German patent application P 26 47 167,0 similar penetrating beams a special x-ray tube suggested for a method the production of tomographies with Röntgenoder, which contains in a vacuum flask a plurality of lattice-controlled cathodes, became, which an anode block faces. By application of corresponding potentials at the control grids a moving focal spot becomes obtained. This can by the photograph organ and/or. the desired receptacle expiration controlled become. The fineness of the division of adjacent focal spots is limited however with this formation downward by the space requirement of the support of cathodes and grids.

With Roentgen diagnostics equipment to the production of transverse layer pictures a X ray source suggested with an annular formed anode in accordance with DT-patent application P 26 50 237,4, which is an opposite number of cathodes disposed, dependent of the desired measured value number, became, which are gradually switched on. This can take place about in such a way that all cathodes simultaneous are because of filament voltage and that a step switching mechanism is for successive turning of the negative pole of an high voltage source on to the cathodes present, whereby the positive pole of the high voltage source with the anode is connected. In the case of such an array without control grids however the difficulty results that rapid alternate switching on of the high voltage on at the respective anode cathode system can become only accomplished with relative high effort. In addition, the proposal covers a X ray tube with in other older proposal contained use of a control grid, which is limited by the space requirement of the combination cathode and grid in the division of the beam source downward.

The invention has itself opposite the state of the art the object provided to indicate an array with which tomography times bottom 80 MSEC and preferably at least down to 20 MSEC are more achievable. Opposite the older patent applications the object exists in a simplification kon of the struktiven structure and making finer divisions of the beam source as well as avoidance of the expenditure possible, which exists with arrays without control grids. This object becomes according to invention by in the characterizing part of the claim 1 indicated measure dissolved.

By the array of a single anode sufficient form and size as well as one the desired measured data adapted number of cathodes, which face the anode, and a common (galvanic not separated) control grid the structure of the tubes becomes simplified, because is necessary for the grid only a support. This conditional also that one can arrange the single beams in shorter distances, which are called that one the desired measured value number increase can. Otherwise the space required for the attachment of each cathode associated grids can be consulted for mounting other cathodes. The control grid can have arbitrary form just like the anode.

For the Zonoskopie and for the computer tomography obtained both anode and control grid the form of a ring. The control grid (ehnelt) can consist of a metal ring, which has rinnenförmiges profile in the cross section. The wall, which interconnects the two side walls of the channels, can contain slits of in-punched or stated, which become then effective as control grids. To each slit belongs heating spiral, whose terminals are led out from the vacuum flask of the tubes. Coils the galvanic are to be separated, so that separated engagement of the cathodes becomes possible. The separation can e.g. take place via inductive transmission of the filament current or via indirect heater. The control grid is because of fixed potential this becomes a so selected that with the potential located in the off state at the cathode no tube stream can flow. Thus the difficulty specified in the introduction becomes avoided, because the space requirement of the control grid is smaller due to permissible galvanic coupling.

The circuit and/or. Control of the tube stream made by change of the cathode potential, as the cathode potential is so far negative in relation to the lattice potential that the straight desired current flows. For the Zonoskopie for instance a circuit can become applied, like it e.g. described is in DT-OS 22 23 021. For

the computer tomography the circuit principles are more applicable, which are in our application P 2650 237,4 indicated.

The mechanical arrangement can take place in such a way that an annular anode is used, their body in the cross section triangular shape exhibits and the grid a band shaped ring, which has rectangular bent side walls. Both the anode ring and the tax lattice ring become then concentric to each other disposed, in such a manner that that faces the Seiternqände of the grid interconnecting band shaped part of the control grid of the hypotenuse of the actual cross section of the anode and the bending parallel run to one of the cathodes. The anode ring can be thereby within the tax lattice ring or outside; in addition, an array with same diameter is possible next to each other. The latter will be with the large rings convenient in particular, which must find for the computers tomography use, so that the body without motion of the tubes, which can be through-radiated, can be through-radiated by all sides. In addition the band shaped connection of the two side walls of the grid is vertical to the axis of the grid and the anode stored with this formation. The hypotenuse of the triangular cross section of the anode is inward inclined thereby so that outgoing beams become in the manner known with X ray tube the center of the anode ring radiated.

Other details and advantages of the invention become subsequent on the basis the Ausflihrungsbei drawn in the figs play explained.

In the Fig. 1 is the chart designed of a according to invention Röntgenschichtaufnahmean order for planar layers shown, in the Fig. 2 in the circuit diagram for the motion of the focal spot over the anode, in the Fig. 3 one of an array with more annular

Anode cut off half and in the Fig. 4 a likewise cut off half from egg of ner array, which is graphie suitable for the computer Tomo.

In the Fig. 1 is a x-ray unit drawn, with which at a Stativsäule 1 vertical a slidable patient storage plate 2 and a beam source 3 mounted are. In addition in the operation still another electric supplying arrangement is 4 provided. This becomes supplied of the network. With a receptacle in the sense of the invention a X ray tube becomes 5 in operation set and a radiographic film cartridge 6 accommodated in the table 2 toward an arrow 7 in motion set by means of the power supply 4. A focal spot of approx. becomes in the tubes. 1 x 1 mm2 generated. Thus a jet cone becomes 8 manufactured and by migration of the engagement of with 9 suggested cathodes along the arrow 10 the opposite direction, becomes displaced in which the cartridge, moved. The distances of the cathodes 9 from each other are same and amounted to approx. 0,5 to approx. 2 cms.

The engagement of a cathode becomes synchronized in simple manner with the motion of the cartridge, by in Fig. 2 broken suggested path of movement 11 adjacent switch 12 to 16 associated is. All these switches are opened and become only with the Vorübergleiten of the cartridge briefly closed. Thus in each case a corresponding negative potential applied becomes at the heating spiral, thus the cathode 9, opposite the anode 17. The switches have toward the arrow 7 distances of 2,5 cms from each other, which corresponds also to the distances of the anodes 9 from each other.

The electrical supply of the tubes 5 made of the power supply 4 over lines 17 ', 19, 20 and 28 of corresponding output Poland of the mechanism 4, which are indicated by DC power source 18 and 27 and a source of alternating voltage 21 of 50 hzs; center frequencies and radio frequencies are in addition, more applicable, because this depends only on the kind of the transformer or transmitter. The fact that the mechanism contains 4 also actuatable switching on means is indicated by the switch symbol 4 '. The actual X ray producing potential difference is appropriate 17 ' and 28 between the lines. The filament voltage for the hot cathodes 9 becomes transmitted inductive through by the wall of the tubes 5. The grid voltage is 28 applied between the lines 19 and. In addition a filament transformer is provided for each heating spiral, whose primary winding is appropriate outside and for its secondary winding within the tubes 5. Thus the cathodes become 9 proper galvanic from each other separated.

In the circuit the voltage source 18 means the source of anode voltage of approx. 90 kV, the source 21 the source of filament voltage of approx. 10 V and the source 27 the Gitterspannungsquelle of approx. 100 to 1000 V.

With the operation of the mechanism becomes, as in Fig. 1 indicated, an X-ray bundle of 8 generated, which moves along the arrow 10 into the position 8 '. Thus a movement transillumination becomes achieved, how it is required to the conventional tomography.

In the Fig. 3 as of of tubes cut off half suggested formation concentric contains to each other an annular constructed grid 29 and an annular anode 30 disposed concentric within this ring to it.

The grid consists of an annular bent band, whose side walls are rectangular bent. Those the two bending interconnecting with one another side 31 of the grid 29 is appropriate for parallel to the axis, bent around which it is in its ring shape. The bending are appropriate thereby for vertical to the axis outward; while a side 32 is because of the inside of the annular anode, second with 33 designated vertical is to the axis and parallel to the bent side walls of the grid 29. The hypotenuse 34 includes one with the axis inlcel and lies opposite the side 31 of the grid 29. This grid e.g. exists. from Nickel-Blech, which approx. 0.2 mm strong is. The anode 30 consists of tungsten.

The dimensions of the grid 29 are in present example so designed that the diameter approx. 20 to 70 cms, the width of the side 31 approx. 1 to 2 cms and the width of the bending approx. 1 to 2 cms amount to. The anode 30 has a diameter of approx. 10 to 60 cms, a side 32 of approx. 2 cms, a side 33 of approx. 1 cm and a hypotenuse 34 of approx. 2.5 cms.

At the inside 31 of the grid 29 slits are 35 in-punched, those approx. 1 mm wide and approx. 1 cm prolonged are. They are evenly distributed and have distances of approx. 0,5 to 2 cms from each other. Rear each pointed 35 is an hot cathode, of which at the cut end of the grid 29 those are more visible in each case, which is with 36 and 37 designated.

They have lines 38 and 39 as well as 40 and 41, which are led out from the gläsernen vacuum flask 42. The remaining leading out are 43 designated with the reference numeral. Between the lines the 38 and 39 and/or. 40 and 41 located filament voltage is by the respective alternating voltage generator symbol 44 and 45 indicated. The high voltage required for X-ray production becomes 46 supplied of a voltage

supply unit. In addition are as batteries 47 and 48 symbolized, over a line 49 29 DC source provided connected with the grid, which are more connectable in addition over switches 50 and 51 with the cathodes 36 and 37.

In the operation the function of the tubes is after Fig. to describe 3 as follows: By the equal number of switches (in Fig. 3 only switch 50 and 51 drawn), which corresponds to the number of the cathodes, the equal number of voltage sources becomes (in Fig. 3 only 47 and 48 drawn) alternate deenergized, so that between grids no reverse voltage lies close 29 and the respective connected cathode. Thus a tube stream can flow from the connected in each case cathode to the anode 30.

In the Fig. 4 is a X ray tube 52 drawn insertable for the computer tomography. It covers an annular bent anode 54, a grid 55 and a number of approx. in a vacuum-tight gläsernen bulb 53. 10 to approx. 300 hot cathodes, of which the 57 at the cut end grids are more visible in each case 55 designated with 56 and. The formation of the anode and the grid tunes actual with that after Fig. 3.

Only the array is going by changed that both the anode 54 and the grid 55 have same diameter of 30 to 150 cms and that it around the same axis to lie side by side. In addition the side 58 of the grid provided with slits and the hypotenuse 59 of the triangular cross section of the anode are one on the other in axial direction with this formation. The inclination of the hypotenuse of the triangular cross section points to the axis from grids 58 and anode, so that with the radius of approx. 150 cms, which is here provided, the tubes in the computer tomography is more insertable. The circuit is, as with the tubes in Fig. 3 indicated, possible.

The tube arrangement according to invention is also for pure electronic paint-on processes without moved cartridges (6, Fig. 1 and 2) more applicable. Then simulating of a corresponding motion required because of the mixture for the layer representation, i.e. the continuous-switching operation that tubes, can take place with a Steuergenerator and the synchronous motion of the image via receptacle with a radiograph amplifier and a magnetic deflection of the output image (see. e.g. DT-patent application P 27 12 320,2).

Claims 1. X ray tube to the production of body layer pictures by means of scanning moved X-ray federation ice, whereby the source with one is the scanning movement corresponding formed anode, a plurality of the anode opposed cathodes and these upstream control grids provided, a D A D u r C h g e k e n n z e i C h n e t that all grids are because of a common potential and that the continuous-switching operation of the beam by separated engagement of the cathodes made.

2. Tubes according to claim 1, characterised in that the grid just like the anode a metallic ring is, whereby however the grid has apertures for the passage of the electrons coming from the cathode.

3. Tubes according to claim 2, characterised in that the anode ring within the lattice ring lies.

4. Tubes according to claim 2, characterised in that the diameters of anode ring and lattice ring equally large are and that they are appropriate for same oh victory next to each other.

5. Tubes according to claim 2, characterised in that the grid from an annular bent sheet metal part is, which has u-shaped profile in the cross section and with that the lattice openings in the bar between the side walls to lie.

6. Tubes according to claim 1, characterised in that the filament current inductive transmitted and an alternating current a frequency of approx. becomes. 50 hzs to approx. more kHz, in particular 500 hzs, is.

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Nummer: 27 29 353
Int. Cl.²: H 01 J 35/24
Anmeldetag: 29. Juni 1977
Offenlegungstag: 11. Januar 1979

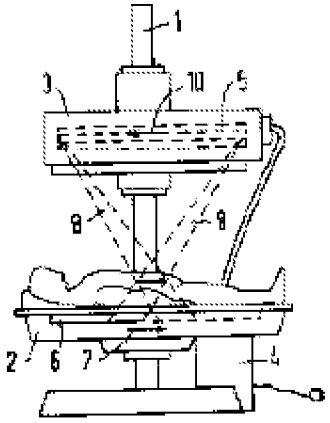

Fig. 1

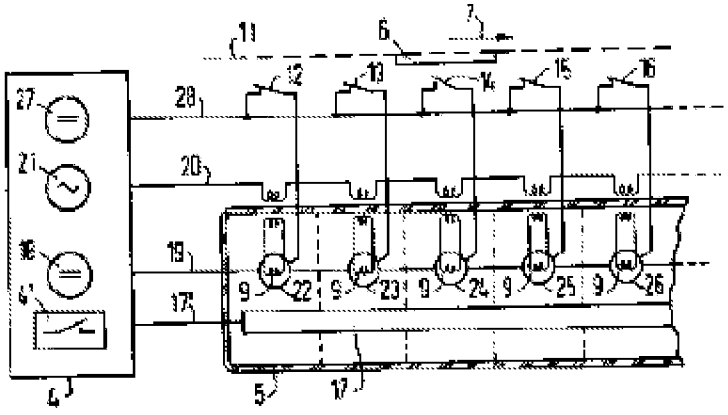

Fig. 2

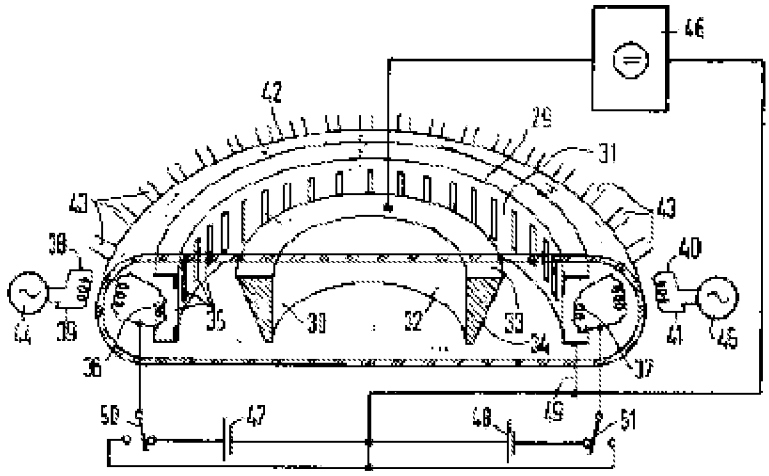
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Fig. 3

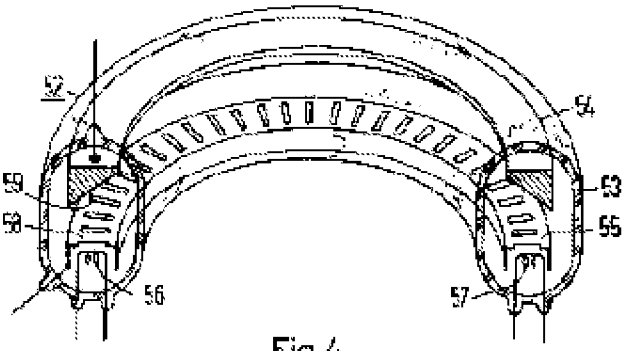
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Fig. 4